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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Ian Kinloch

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PATENT ADMINISTRATOR
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BOSTON, MA 02109-2881

EXAMINER

HAILEY, PATRICIA L

ART UNIT

PAPER NUMBER

1793

NOTIFICATION DATE

DELIVERY MODE

12/09/2008

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No. 10/534,900	Applicant(s) KINLOCH ET AL.	
	Examiner PATRICIA L. HAILEY	Art Unit 1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 05 September 2008.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-6,12-19,21-34,36 and 37 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-6,12-19,21-34,36 and 37 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

Applicants' remarks and amendments, filed on September 5, 2008, have been carefully considered. Claims 7-11, 20, and 35 have been canceled; no new claims have been added.

Claims 1-6, 12-19, 21-34, 36, and 37 remain pending in this application.

Priority

1. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Applicants' Priority Document was filed on May 13, 2005.

Withdrawn Objection

The objection to claim 14 stated in the previous Office Action has been withdrawn in view of Applicants' amendment to change its dependency to claim 1.

New Grounds of Rejection

The following New Grounds of Rejection are being made in view of Applicants' amendments to claim 1 (by incorporating therein the subject matter of now-canceled claims 8 and 20); the text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claim Rejections - 35 USC § 103

2. *Claims 1-6, 12, 13, 21, 24, 25, 32-34, and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over WO 00/17102 (hereinafter "the WO document") in view of Hwang et al. (U. S. Patent No. 6,855,376).*

The WO document teaches a method for the production of single-wall carbon nanotubes, wherein a supported transition metal catalyst (supported on an inert surface) is brought into contact with a suitable feedstock gas at a temperature and pressure at which single-wall carbon nanotube growth occurs (**claim 1**). See page 4, lines 20-24 of the WO document.

The transition metal catalyst may be provided on a chemically compatible, refractory nanoscale support particle. Examples of the support include alumina, carbon, quartz, silicates, and aluminum silicates; the support may take the form of spheres, irregularly shaped particles, flakes, and the like. Preferred are supports that provide substantially planar surfaces, e.g., flakes; further, the support "may range in size from about 10 nm to centimeters." See page 8, line 26 to page 9, line 2 of the WO document (considered to read upon **claims 12 and 35**--if the length and breadth of the particle faces are of the same size--as well as **claims 3 and 13**).

Examples of the transition metal catalyst include metals such as iron, cobalt, nickel, molybdenum, and mixtures thereof. See page 9, lines 4-18 of the WO document (considered to read upon **claim 21**).

The transition metal clusters may have a size of from about 0.5 nm to over 30 nm. The transition metal clusters may be dispersed on the support surface so that there is clear separation between the clusters, so that the single-wall nanotubes that grow from the support are separate from one another. See page 9, lines 19-30 of the WO document (considered to read upon **claims 4-6**).

Examples of the feedstock include suitable carbon-containing compounds such as carbon monoxide, benzene, toluene, xylene, cumene, ethylbenzene, naphthalene, phenanthrene, anthracene, methane, ethane, propane, ethylene, propylene, acetylene, formaldehyde, acetaldehyde, acetone, methanol, ethanol, or mixtures thereof. See page 10, lines 15-23 of the WO document (considered to read upon **claims 24 and 25**).

In the method disclosed by the WO document, the reaction temperature ranges from about 700°C to about 1200°C. Additionally, the carbon feedstock may be recycled through the reactor to increase utilization of the feedstock. See page 12, lines 12-20 of the WO document (considered to read upon **claims 33 and 34**).

The carbon nanotubes produced by the method disclosed in the WO document exhibit diameters ranging from about 0.5 to about 3 nm, and may have lengths exceeding 1 micron. See page 15, lines 18-25 of the WO document (considered to read upon **claim 36**).

Additionally, nanotubes prepared according to this method may be removed from the supported catalyst for subsequent processing and/or utilization, or may be used "as is" while still attached to the catalyst particle. They may also be collected

individually for particular uses. See page 16, lines 2-8 of the WO document (considered to read upon **claim 32**).

The WO document does not explicitly teach that the support exhibits radii of curvature of more than 1 μm or more than 10 μm , or a length and breadth between 1 μm and 5 mm, or between 10 μm and 500 μm . However, because the WO document discloses that the support can have substantially planar surfaces, can be irregularly shaped particles, and may “range in size from about 10 nm to centimeters” (page 8, line 26 to page 9, line 2), it would have been obvious to one of ordinary skill in the art at the time the invention was made to select support particles within the disclosed size range that would also exhibit radii of curvature greater than 1 or 10 μm , motivated by the teachings of the WO document, and by Applicants’ claim limitations regarding the length and breadth of the substrate/support particles, which implies that the length and breadth can be identical or nearly so.

Although the WO document discloses exemplary methods for depositing catalyst material onto a support (using known methods, and can be prepared in advance in fully active form, prepared in precursor form followed by an activation step, or formed in situ in the reaction zone; see page 9, line 31 to page 10, line 7 of the WO document), this reference does not teach or suggest the techniques recited in claim 1.

Hwang et al. disclose a process of direct growth of carbon nanotubes, wherein a metal support layer is formed on a substrate, a metal catalyst layer is formed on said metal support layer, a bonding layer is formed on said catalyst metal layer, and carbon

nanotubes are grown on a surface of said multi-layered substrate, under conditions of a reaction temperature of 400°-600°C and a carbon source gas comprising a hydrocarbon or carbon monoxide (col. 4, lines 26-30 of Hwang et al.; note that the carbon source gas is comparable to the carbon-containing gases disclosed in the WO document, and that the temperature range of Hwang et al. falls within the range disclosed in the WO document).

The metal catalyst layer comprises a metal selected from the group consisting of Fe, Co, Ni, and an alloy thereof (note that these metals are recited in the WO document), and is formed by vacuum sputtering, CVD, physical vapor deposition (PVD), screen printing, or electroplating. See col. 3, lines 45-58 and col. 4, lines 9-12 of Hwang et al.

In view of the similarities between Hwang et al. and the WO document, regarding the respective methods/conditions of producing carbon nanotubes and the respective catalysts disclosed therein, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of the WO document by incorporating therein the catalyst deposition techniques disclosed in Hwang et al., as these references show exemplary techniques for depositing a catalyst onto a substrate, said catalyst being employed in methods for producing carbon nanotubes.

3. *Claims 1, 2, 12, 13, 15, 19, 19, 21, 22, 24, 25, 29-34, 36, and 37 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Resasco et al. (U. S. Patent No. 6,413,487) in view of Hwang et al. (U. S. Patent No. 6,855,376).*

Resasco et al. disclose a method for producing carbon nanotubes, wherein catalytic particles are subjected to exposure of an effective amount of a carbon-containing gas (such as carbon monoxide, aliphatic hydrocarbons, both saturated and unsaturated, oxygenated hydrocarbons, aromatic hydrocarbons, etc., which may optionally be mixed with a diluent gas, see col. 8, lines 10-22 of Resasco et al.; considered to read upon **claims 24, 25, and 29**), that is heated to a suitable reaction temperature (e.g., about 750°C, see col. 10, lines 47-51; considered to read upon **claim 34**), during which stage carbon nanotubes and amorphous carbon are formed on the catalytic particles. See col. 4, lines 16-26 of Resasco et al.

The catalyst particles comprise a solid support material which first has been impregnated with a metallic catalyst, then calcined and preferably processed into a pellet form, followed by treatment with an inert gas and with a reducing gas. The pelletization process can be performed either before or after the support material is impregnated with the catalyst (transition metal precursor). See col. 2, lines 33-45 of Resasco et al.; considered to read upon **claims 18 and 19**).

Examples of the catalytic metals include cobalt, nickel, and molybdenum. See col. 7, lines 12-62 of Resasco et al. (considered to read upon **claim 21**), which also discloses exemplary catalytic metal precursor compounds such as bis

(cyclopentadienyl) cobalt or bis (cyclopentadienyl) molybdenum chloride (considered to read upon **claim 22**), and exemplary supports (silica, alumina, zirconium oxide, MCM-41 – Mobil Crystalline Material-41, magnesium oxide, or other oxidic supports known in the art; considered to read upon **claim 13**, as well as the limitation “anisotropic” in **claim 15**).

The process of Resasco et al. involves bringing heated catalytic particles into contact with a heated carbon-containing gas in a reactor enables for the gases supplied thereto to be recycled after having been output from said reactor. See col. 12, lines 7-26 of Resasco et al. (considered to read upon **claim 33**).

The process of Resasco et al. may be a fluidized bed or quasi-continuous batch and fluidized bed process. See col. 12, line 47 to col. 13, line 45 of Resasco et al. (continued to read upon **claims 30 and 31**).

The amorphous carbon particles are burned away from the catalytic particles via oxidation, substantially leaving only carbon nanotubes in the particles. The catalytic particles are then subjected to a purification process which results in the separation of the catalysts (bearing the nanotubes) from the support, for example, by dissolving by treatment with a base. See col. 4, lines 34-61 of Resasco et al. (considered to read upon **claims 32, 36, and 37**).

Resasco et al. does not disclose that the supports therein exhibit radii of curvature of more than 1 μm or more than 10 μm , or a length and breadth between 1 μm and 5 mm, or between 10 μm and 500 μm . However, because Resasco et al. discloses

supports reading upon that instantly claimed, and also discloses a process comparable to that instantly claimed, it would have been obvious to one of ordinary skill in the art at the time the invention was made to reasonably expect the supports of Resasco et al. to exhibit properties such as radii of curvature, length, and breadth, in values or amounts comparable to that instantly claimed, absent the showing of convincing evidence to the contrary.

Although Resasco et al. disclose exemplary methods for depositing catalyst material onto a support this reference does not teach or suggest the techniques recited in claim 1.

Hwang et al. disclose a process of direct growth of carbon nanotubes, wherein a metal support layer is formed on a substrate, a metal catalyst layer is formed on said metal support layer, a bonding layer is formed on said catalyst metal layer, and carbon nanotubes are grown on a surface of said multi-layered substrate, under conditions of a reaction temperature of 400°-600°C and a carbon source gas comprising a hydrocarbon or carbon monoxide (col. 4, lines 26-30 of Hwang et al.; note that the carbon source gases are comparable to the carbon-containing gases disclosed in Resasco et al.).

The metal catalyst layer comprises a metal selected from the group consisting of Fe, Co, Ni, and an alloy thereof (note that these metals are recited in Resasco et al.), and is formed by vacuum sputtering, CVD, physical vapor deposition (PVD), screen printing, or electroplating. See col. 3, lines 45-58 and col. 4, lines 9-12 of Hwang et al.

In view of the similarities between Hwang et al. and Resasco et al., regarding the respective methods/conditions of producing carbon nanotubes and the respective catalysts disclosed therein, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Resasco et al. by incorporating therein the catalyst deposition techniques disclosed in Hwang et al., as these references show exemplary techniques for depositing a catalyst onto a substrate, said catalyst being employed in methods for producing carbon nanotubes.

4. *Claims 4-6, 14, 16, 17, 21, and 24-26 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Resasco et al. (U. S. Patent No. 6,413,487) in view of Hwang et al. (U. S. Patent No. 6,855,376) as applied to claims 1, 13, and 15 above, and further in view of Someya et al. (U. S. Patent No. 6,967,013).*

Resasco et al. in view of Hwang et al. are relied upon for their teachings with respect to claims 1, 13, and 15. Although these references disclose exemplary supports such as those recited in claims 13 and 15, the reference does not teach or suggest the limitations recited in claims 14, 16, 17, and 26.

Someya et al. disclose a process for producing aligned carbon nanotube films, wherein a carbon compound is decomposed using a substrate coated with an element having no catalytic activity by itself (considered to read upon the limitation "buffer layer" in **claim 17**), and which loads a metallic element having catalytic ability or a

compound thereof, thereby forming a film of fine carbon nanotubes on the surface of the substrate which are aligned in a direction perpendicular to the substrate. See the Abstract of Someya et al., as well as col. 2, lines 49-58.

The substrate can be formed of silica, alumina, aluminum, etc. See col. 2, lines 59-64 of Someya et al. (considered to read upon the limitation "aluminium" in **claim 14**).

Examples of the metallic element having catalytic ability include cobalt, nickel, iron, or a mixture of cobalt and nickel, in the form of particles generally having sizes between 0.1 and 50 nm. See col. 3, lines 32-44 of Someya et al. (considered reading upon claims 4-6; noting that these elements are also disclosed in Resasco et al.).

In Example 1 of Someya et al., a square substrate measuring 2 mm thick and 75 mm on each side (considered to read upon "one dimension smaller than the other two dimensions" in **claim 16**) having aluminum deposited thereon by vacuum deposition is prepared.

Patentees' process also involves carbon compounds such as saturated hydrocarbons, oxygen-containing hydrocarbon compounds (e.g., methane, ethane, propane, etc.; compounds the same as, or similar to, those recited in Resasco et al. and recited in Applicants' **claims 24 and 25**) introduced in gaseous form or in mixture with an inert gas; the carbon compound may also be mixed with a compound containing a hetero element such as boron or nitrogen (considered to read upon **claim 26**). The aforementioned carbon compounds are decomposed via pyrolysis at reaction

temperatures between 400°C and 1100°C (comparable to the temperature range recited in Resasco et al.). See col. 4, line 60 to col. 5, line 12 of Someya et al.

In view of the similarities between Someya et al., Resasco et al., and Hwang et al. regarding the respective methods/conditions of producing carbon nanotubes and the respective catalysts disclosed therein, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Resasco et al. and Hwang et al. by incorporating therein the substrates disclosed in Someya et al., as the respective substrates are known in the art of producing carbon nanotubes.

5. *Claims 21-29 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Resasco et al. (U. S. Patent No. 6,413,487) in view of Hwang et al. (U. S. Patent No. 6,855,376) as applied to claim 1 above, and further in view of Arakawa (U. S. Patent No. 4,572,813).*

Resasco et al. in view of Hwang et al. are relied upon for their teachings with respect to claim 1. Although Resasco et al. in view of Hwang et al. additionally read upon claims 21, 22, 24, and 25, this reference does not teach or suggest the limitations of claims 27 and 28.

Arakawa teaches a process for preparing carbon fibers by reacting a mixed gas consisting of a gas of organic metal compound or compounds, a carrier gas, and desirably a gas of carbon compound or compounds at temperatures ranging between

600° to 1300°C (comparable to the temperatures disclosed in Resasco et al.), in which fibers having a diameter of 0.05 to 2 μm , a length of 2-3000 μm , and an aspect ratio of 2 to 30,000 may be produced. See the Abstract of Arakawa.

Examples of the organic metal compounds include carbonyl compounds of metals such as iron, cobalt, and nickel; specific examples include iron pentacarbonyl ($\text{Fe}(\text{CO})_5$), nickel tetracarbonyl ($\text{Ni}(\text{CO})_4$). See col. 2, line 49 to col. 3, line 41 of Arakawa (considered to read upon **claims 21-23**).

The carrier gas may be an inert gas, such as nitrogen. See col. 3, lines 42-50 of Arakawa (considered to read upon **claims 26 and 29**).

Examples of the carbon compound or compounds (used as a carbon source) include carbon monoxide (CO), alkanes such as methane and ethane, alkenes such as ethylene, alkynes such as acetylene, aryl hydrocarbons such as benzene and toluene, aromatic hydrocarbons such as naphthalene, and heterocyclic compounds such as thiophene. A mixture of these compounds may also be used. Further, the carbon compound may also contain nitrogen and other elements. See col. 3, line 51 to col. 4, line 14 of Arakawa (considered to read upon **claims 24, 25, 27 and 28**).

In view of the similarities between Arakawa and Resasco et al. regarding the respective components employed in methods of producing carbon nanotubes, and the respective catalyst precursors disclosed therein, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of

Resasco et al. by incorporating therein the catalyst precursors disclosed in Arakawa, as the respective catalyst precursors are known in the art of producing carbon nanotubes.

Further, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Resasco et al. by incorporating therein thiophene, as suggested by Arakawa, because both Resasco et al. and Arakawa teach the same or similar carbon-containing compounds as carbon sources, in the references' respective methods for producing carbon nanotubes.

Response to Arguments

In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, motivation to combine the references is based on the prior art's teachings regarding the production of carbon nanotubes, and employing comparable catalysts, hydrocarbons, and process conditions to do so.

In response to Applicants' arguments that the cited references do not explicitly show that the "support particle shape or size" influences the production of aligned

nanotubes, the Examiner respectfully submits that Applicants have not sufficiently shown the criticality in the substrate particles exhibiting a specific radius of curvature, which, as Applicants submit, results in the formation of aligned nanotubes. The WO document's teaching that aligned nanotubes may be produced "due to dispersion of transition metal clusters" is not seen to preclude the reference from reading upon Applicants' claims in their present form.

Applicants' arguments with respect to Resasco et al. have been considered, but are not persuasive. Although this reference may not "make any mention" of the dimensions of the catalyst pellets disclosed therein, the reference is relied upon, inter alia, for its teachings regarding the separation of the carbon nanotubes from the catalytic particles.

Applicants' arguments with respect to Hwang et al. have been considered, but are not persuasive. This reference is relied upon for its teachings, inter alia, regarding the formation of catalysts onto substrates via vacuum sputtering, CVD, physical vapor deposition (PVD), screen printing, or electroplating.

Applicants' arguments with respect to Someya et al. and Arakawa have been considered but are not persuasive. These references were relied upon for their teachings with respect to claims 14, 16, 17, and 26 (Someya et al.) and to claims 27-29 (Arakawa), and for their relevance in the art of producing carbon nanotubes.

The Examiner respectfully submits that when a reference teaching more than that what is recited in Applicants' claims does not preclude the reference from reading upon Applicants' claims in their present form.

For these reasons, Applicants' arguments are not persuasive.

Conclusion

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to PATRICIA L. HAILEY whose telephone number is

(571)272-1369. The examiner can normally be reached on Mondays-Fridays, from 7:00 a.m. to 3:30 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo, can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group 1700 Receptionist, whose telephone number is (571) 272-1700.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/PATRICIA L. HAILEY/
Primary Examiner, Art Unit 1793
December 1, 2008